

## CLAIMS

1. An organic electrolyte battery separator, which is composed of a nonwoven comprising a heat-and-humidity gelling resin capable of gelling by heating in the presence of moisture and another fiber,
  - 5 the other fiber being fixed with a gel material obtained by causing the heat-and-humidity gelling resin to gel under heat and humidity, and
  - 10 the nonwoven having a mean flow pore diameter of 0.3  $\mu\text{m}$  to 5  $\mu\text{m}$  and a bubble point pore diameter of 3  $\mu\text{m}$  to 20  $\mu\text{m}$  as measured in accordance with ASTM F 316 86.
2. The organic electrolyte battery separator according to claim 1, wherein the heat-and-humidity gelling resin is a heat-and-humidity gelling fiber, the heat-and-humidity gelling resin being provided at least 15 at a portion of a surface of the heat-and-humidity gelling fiber.
3. The organic electrolyte battery separator according to claim 1, wherein a proportion of the nonwoven occupied by the heat-and-humidity gelling resin is in a range of 10 mass% to 50 mass%.
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4. The organic electrolyte battery separator according to claim 1, wherein the heat-and-humidity gelling resin is an ethylene-vinyl alcohol copolymer.
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5. The organic electrolyte battery separator according to claim 1, wherein the other fiber has a fiber diameter of 15  $\mu\text{m}$  or less.
6. The organic electrolyte battery separator according to claim 1, wherein an average fiber diameter of the other fiber constituting the nonwoven is 10  $\mu\text{m}$  or less.
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7. The organic electrolyte battery separator according to claim 1, wherein the fiber constituting the nonwoven other than the heat-and-humidity gelling resin is an olefin fiber.
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8. The organic electrolyte battery separator according to claim 1,

wherein the other fiber includes a high-strength fiber having a single fiber strength of 4.5 cN/dtex or more in a range of 5 to 250 parts by mass where the heat-and-humidity gelling resin is assumed to be 100 parts by mass.

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9. The organic electrolyte battery separator according to claim 1, wherein the other fiber includes a heat-melting fiber that does not substantially shrink at a temperature that causes the heat-and-humidity gelling resin to gel under heat and humidity to fix the other fiber, in a range of 10 to 300 parts by mass where the heat-and-humidity gelling resin is assumed to be 100 parts by mass.

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10. The organic electrolyte battery separator according to claim 1, wherein the nonwoven further comprises a synthetic pulp in addition to the other fiber.

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11. The organic electrolyte battery separator according to claim 1, wherein the synthetic pulp is included in a range of 10 to 200 parts by mass where the heat-and-humidity gelling resin is assumed to be 100 parts by mass.

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12. The organic electrolyte battery separator according to claim 2, wherein an average fiber diameter of the heat-and-humidity gelling fiber and the other fiber is 10  $\mu\text{m}$  or less.

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13. The organic electrolyte battery separator according to claim 2, wherein the heat-and-humidity gelling fiber has a fiber diameter of 1 to 6  $\mu\text{m}$ .

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14. The organic electrolyte battery separator according to claim 13, wherein the heat-and-humidity gelling fiber is a fiber provided by splitting a splittable composite fiber that contains the heat-and-humidity gelling resin and another resin, which are adjacent to each other in a cross-section of the fiber.

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15. The organic electrolyte battery separator according to claim 14, wherein, when the splittable composite fiber comprised of the

heat-and-humidity gelling resin and another resin, which are adjacent to each other in a cross-section of the fiber, to be able to provide the heat-and-humidity gelling fiber, is assumed to be 100 parts by mass,

5 the nonwoven comprises, as the other fiber, a high-strength fiber having a single fiber strength of 4.5 cN/dtex or more in a range of 10 to 200 parts by mass, and

10 the nonwoven further comprises a heat-melting fiber that does not substantially shrink at a temperature that causes the heat-and-humidity gelling resin to gel under heat and humidity to fix the other fiber, in a range of 10 to 200 parts by mass.

15 16. The organic electrolyte battery separator according to claim 14, wherein, when the splittable composite fiber comprised of the heat-and-humidity gelling resin and another resin, which are adjacent to each other in a cross-section of the fiber, to be able to provide the heat-and-humidity gelling fiber, is assumed to be 100 parts by mass,

20 the nonwoven comprises, as the other fiber, a high-strength fiber having a single fiber strength of 4.5 cN/dtex or more in a range of 6.25 to 120 parts by mass,

25 the nonwoven further comprises a heat-melting fiber that does not substantially shrink at a temperature that causes the heat-and-humidity gelling resin to gel under heat and humidity to fix the other fiber, in a range of 12.5 to 120 parts by mass, and

the nonwoven further comprises the synthetic pulp in a range of 6.25 to 120 parts by mass.

30 17. The organic electrolyte battery separator according to claim 2, wherein the fiber constituting the nonwoven is a short fiber having a fiber length in a range of 1 mm to 20 mm, and the nonwoven is a wetlaid nonwoven obtained by a wetlaying process using the short fiber.

35 18. The organic electrolyte battery separator according to claim 17, wherein the splittable composite fiber is split during the wetlaying step to provide a heat-and-humidity gelling fiber, and the heat-and-humidity gelling fiber is substantially uniformly present in the nonwoven.

19. The organic electrolyte battery separator according to claim 1,

wherein a surface of the nonwoven is partially covered with a film-like gel material.

20. The organic electrolyte battery separator according to claim 19,  
5 wherein an area proportion of the film-like gel material with respect to an entire surface of the nonwoven is in a range of 40% to 90%.

21. The organic electrolyte battery separator according to claim 1,  
10 wherein a contact angle of dechlorinated water dropped on a surface of the nonwoven is 60 degrees or less 5 seconds after dropping of the dechlorinated water.

22. The organic electrolyte battery separator according to claim 1,  
15 wherein the nonwoven has a puncture strength of 2 N or more and a standard deviation of 1.1 N or less.

23. The organic electrolyte battery separator according to claim 22,  
wherein a variation index of the puncture strength of the nonwoven is 0.165 or less, the variation being calculated from the puncture strength  
20 and the standard deviation using the following expression:

variation index of puncture strength = standard deviation/puncture strength.

25. 24. The organic electrolyte battery separator according to claim 1,  
wherein the separator has a thickness in a range of 15  $\mu\text{m}$  to 80  $\mu\text{m}$  and the nonwoven has a specific volume in a range of 1.2  $\text{cm}^3/\text{g}$  to 2.5  $\text{cm}^3/\text{g}$ .

25. A method for producing an organic electrolyte battery separator  
30 composed of a nonwoven comprising a heat-and-humidity gelling fiber in which a resin capable of gelling by heating in the presence of moisture is present on at least a portion of a surface of the fiber, and another fiber, the method comprising at least steps of:

- A. preparing a nonwoven sheet comprising the heat-and-humidity gelling fiber and the other fiber;
- B. subjecting the nonwoven sheet to a hydrophilic treatment;
- C. providing moisture to the hydrophilic-treated nonwoven sheet

to obtain a water-containing sheet; and

D. subjecting the water-containing sheet to gel processing by a heat-and-humidity treatment using a heat treatment device that is set to a certain temperature within a range of no less than a temperature at 5 which the heat-and-humidity gelling resin gels and no more than "the melting point of the heat-and-humidity gelling resin - 20°C", to cause the heat-and-humidity gelling resin to gel, and fixing the other fiber using the heat-and-humidity gelling resin gel.

10 26. The organic electrolyte battery separator producing method according to claim 25, wherein the average fiber diameter of the nonwoven sheet is 10  $\mu\text{m}$  or less.

15 27. The organic electrolyte battery separator producing method according to claim 25, wherein a proportion of the moisture provided to the hydrophilic-treated nonwoven sheet is in a range of 20 mass% to 300 mass%.

20 28. The organic electrolyte battery separator producing method according to claim 25, wherein a contact angle of dechlorinated water dropped on a surface of the hydrophilic-treated nonwoven sheet is 60 degrees or less 5 seconds after dropping of the dechlorinated water

25 29. The organic electrolyte battery separator producing method according to claim 25, wherein the hydrophilic treatment is an exposure to fluorine gas atmosphere.

30 30. The organic electrolyte battery separator producing method according to claim 25, wherein the gel processing is press processing.

35 31. The organic electrolyte battery separator producing method according to claim 25, wherein the gel processing is press processing using a thermal roller, and a line pressure of the thermal roller is in a range of 350 N/cm to 10000 N/cm.

32. An organic electrolyte battery comprising the separator according to claim 1.